CLAIMS

What is claimed is:

1. An apparatus, comprising:

a heating element for receiving a carrier that supports workpieces thereon in a thermally activated adhesive, the heating element being adapted to heat and reactivate the thermally activated adhesive, and the heating element being movable along an x-axis and a y-axis;

a bimodal pitch adjustment device for aligning with individual ones of the workpieces and displacing said individual ones of the workpieces along a z-axis, the bimodal pitch adjustment device also being movable along the y-axis;

a detainment mechanism for receiving the workpieces when they are displaced from the carrier by the bimodal pitch adjustment device; and

a control processor for controlling operations of the apparatus along the x, y, and z axes, the control processor having full control of all critical process parameters, including accurate and repeatable workpiece placement, controlled temperature and heat flow, and controlled mechanical removal pressure, temporal control, and variability.

2. The apparatus of claim 1, wherein the bimodal pitch adjustment device comprises a beveled tooth that precisely aligns with one of the workpieces, the beveled tooth being tapered in at least two dimensions to provide a small contact area for said one of the workpieces.

3. The apparatus of claim 1, wherein the bimodal pitch adjustment device has a beveled hardened steel tooth for pushing the workpieces individually off of the carrier and placing them directly into the detainment mechanism.

4. The apparatus of claim 1, wherein the detainment mechanism comprises a block and a retention feature removably mounted to the block.

5. The apparatus of claim 4, wherein the block is formed from a material that does not react with either the thermally activated adhesive or the workpieces.

6. The apparatus of claim 1, wherein the detainment mechanism uses spring-loaded keys and workpiece-separating teeth to hold each individual workpiece in the detainment mechanism.

7. The apparatus of claim 6, wherein the keys are formed from a material that does not react with either the thermally activated adhesive or the workpieces.

8. The apparatus of claim 1, further comprising a row realignment mechanism for realigning the workpieces in the detainment mechanism along the z-axis.

9. The apparatus of claim 1, wherein the workpieces are spaced apart from each other at a first y-axis pitch when they are located in the carrier, and the workpieces are spaced apart from each other at a second y-axis pitch, that differs from the first y-axis pitch, when they are located in the detainment mechanism, and the apparatus moves at least one of the heating element, the bimodal pitch adjustment device, and the detainment mechanism incrementally along the y-axis with respect to each other to facilitate alignment therebetween.

10. An apparatus, comprising:

a heating element for receiving a carrier that supports workpieces thereon in a thermally activated adhesive, the heating element being adapted to automatically heat and reactivate the thermally activated adhesive, and the heating element being movable along an x-axis and a y-axis;

a bimodal pitch adjustment device for automatically aligning with individual ones of the workpieces and automatically displacing said individual ones of the workpieces along a z-axis, the bimodal pitch adjustment device also being movable along the y-axis and having a beveled tooth for pushing the workpieces individually off of the carrier;

a detainment mechanism for receiving the workpieces when they are displaced from the carrier by the bimodal pitch adjustment device, the detainment mechanism having spring-loaded keys and workpiece-separating teeth to hold each individual workpiece in the detainment mechanism; and

a control processor for controlling operations of the apparatus along the x, y, and z axes, the control processor having full control of all critical process parameters, including accurate and repeatable workpiece placement, controlled temperature and heat flow, and controlled mechanical removal pressure, temporal control, and variability.

11. The apparatus of claim 10, wherein the beveled tooth precisely aligns with one of the workpieces and is tapered in at least two dimensions to provide a small contact area for said one of the workpieces.

12. The apparatus of claim 10, wherein the detainment mechanism comprises a block and a retention feature removably mounted to the block.

13. The apparatus of claim 12, wherein the block and the keys are formed from materials that do not react with either the thermally activated adhesive or the workpieces.

14. The apparatus of claim 10, further comprising a row realignment mechanism for realigning the workpieces in the detainment mechanism along the z-axis.

15. The apparatus of claim 10, wherein the workpieces are spaced apart from each other at a first y-axis pitch when they are located in the carrier, and the workpieces are spaced apart from each other at a second y-axis pitch, that differs from the first y-axis pitch, when they are located in the detainment mechanism, and the apparatus moves at least one of the heating element, the bimodal pitch adjustment device, and the detainment mechanism incrementally along the y-axis with respect to each other to facilitate alignment therebetween.

16. An apparatus, comprising:

a heating element for receiving a carrier that supports workpieces thereon in a thermally activated adhesive, the heating element being adapted to automatically heat and reactivate the thermally activated adhesive, and the heating element being movable along an x-axis and a y-axis;

a bimodal pitch adjustment device for automatically aligning with individual ones of the workpieces and automatically displacing said individual ones of the workpieces along a z-axis, the bimodal pitch adjustment device also being movable along the y-axis and having a beveled tooth for pushing the workpieces individually off of the carrier, such that the beveled tooth precisely aligns with one of the workpieces and is tapered in at least two dimensions to provide a small contact area for said one of the workpieces;

a detainment mechanism for receiving the workpieces when they are displaced from the carrier by the bimodal pitch adjustment device, the detainment mechanism having a block, a retention feature removably mounted to the block, spring-loaded keys extending from the retention feature, and workpiece-separating teeth on the block to hold each individual workpiece in the detainment mechanism;

a row realignment mechanism for realigning the workpieces in the detainment mechanism along the z-axis; and

a control processor for controlling operations of the apparatus along the x, y, and z axes, the control processor having full control of all critical process parameters, including accurate and repeatable workpiece placement, controlled temperature and heat flow, and controlled mechanical removal pressure, temporal control, and variability.

17. The apparatus of claim 16, wherein the block and the keys are formed from materials that do not react with either the thermally activated adhesive or the workpieces.

18. The apparatus of claim 16, wherein the workpieces are spaced apart from each other at a first y-axis pitch when they are located in the carrier, and the workpieces are spaced apart from each other at a second y-axis pitch, that differs from the first y-axis pitch, when they are located in the detainment mechanism, and the apparatus moves at least one of the heating element, the bimodal pitch adjustment device, and the detainment mechanism incrementally along the y-axis with respect to each other to facilitate alignment therebetween.